B6 98P 699

(12) UK Patent Application (19) GB (11) 2 303 769 (13) A

(43) Date of A Publication 26.02.1997

(21) Application No 9615688.0

(22) Date of Filing 25.07.1996

(30) Priority Data
(31) 07190308 (32) 26.07.1995 (33) JP

(71) Applicant(s)
NEC Corporation

(Incorporated in Japan)

7-1,Shiba 5-Chome, Minato-Ku, Tokyo, Japan

(72) Inventor(s)
Masahiko Tanaka
Kenji Okita

(74) Agent and/or Address for Service
John Orchard & Co
Staple Inn Buildings North, High Holborn, LONDON,
WC1V 7PZ, United Kingdom

(51) INT CL[6]
H04L 1/12

(52) UK CL (Edition O)
H4L LDG L1H10

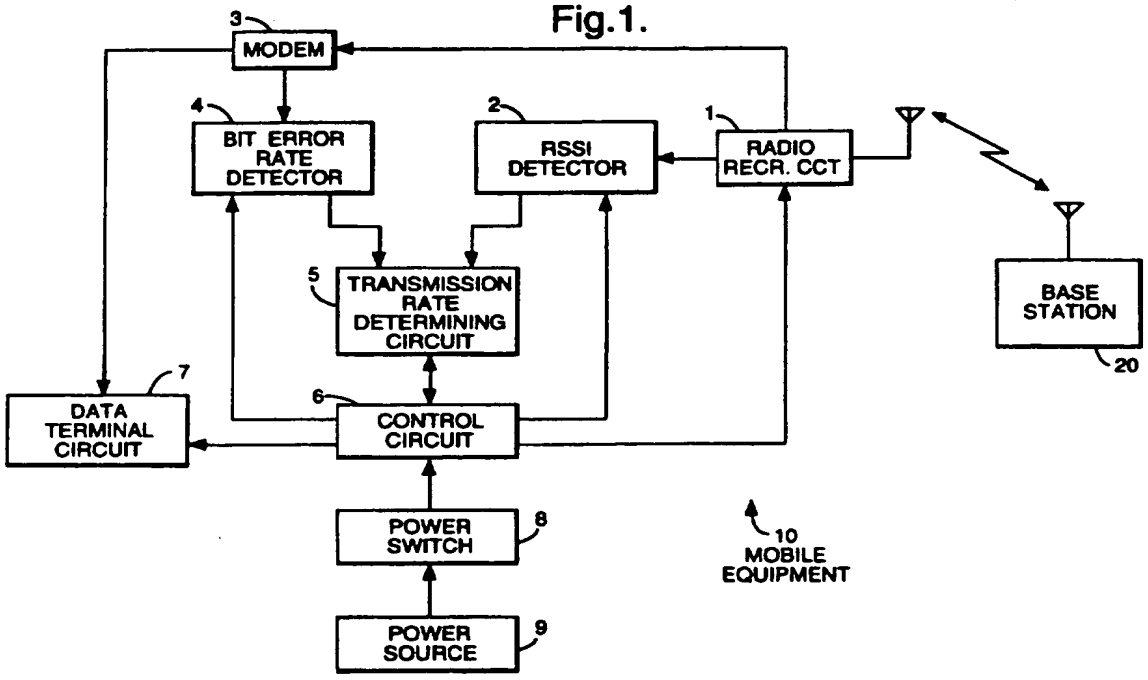
(56) Documents Cited
EP 0565230 A2 WO 92/22162 A1

(58) Field of Search
UK CL (Edition N) H4L LDG , H4P PAQ
INT CL[6] H04B 7/005 , H04L 1/12
ONLINE: WPI

(54) Communication Equipment with Transmission Rate Regulating Function

(57) An RSSI detector detects the level of the electric field of a received signal, and an initial value of the transmission rate is determined from the detected level of the received electric field. A radio circuit transmits the determined initial value to a base station and in response the base station transmits a control signal at the assigned initial value of the transmission rate. A bit error rate detector detects the bit error rate of the control signal and the initial value of the transmission rate is fine regulated according to the detected bit error rate in order to determine an optimal transmission rate.

Fig.1.



GB 2 303 769 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

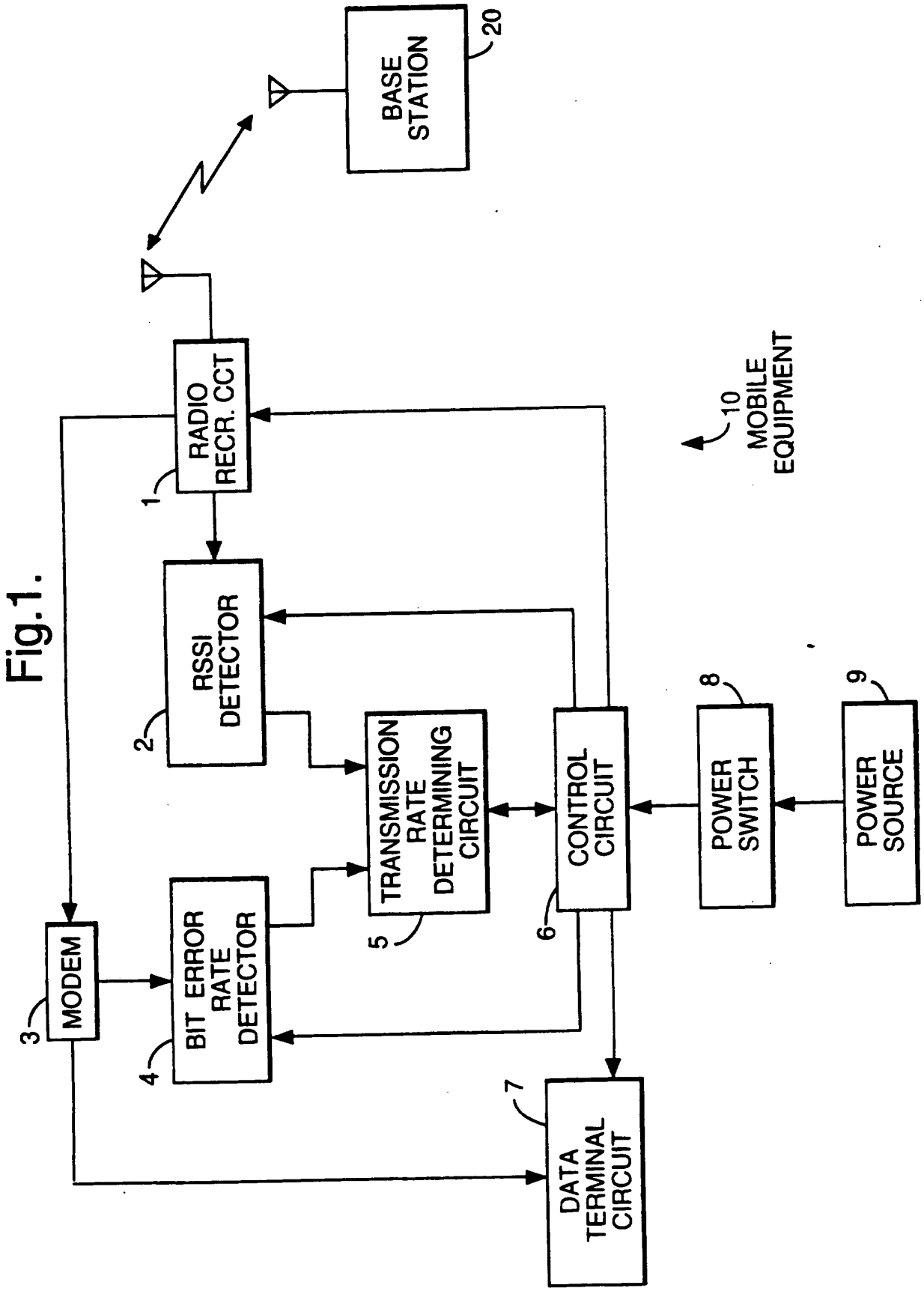

BASE STATION
20
RADIO RECR. CCT
1
RSSI DETECTOR
2
TRANSMISSION RATE DETERMINING CIRCUIT
5
CONTROL CIRCUIT
6
POWER SWITCH
8
POWER SOURCE
9
MODEM
3
BIT ERROR RATE DETECTOR
4
DATA TERMINAL CIRCUIT
7
10
MOBILE EQUIPMENT

Fig.1.

Fig.2.

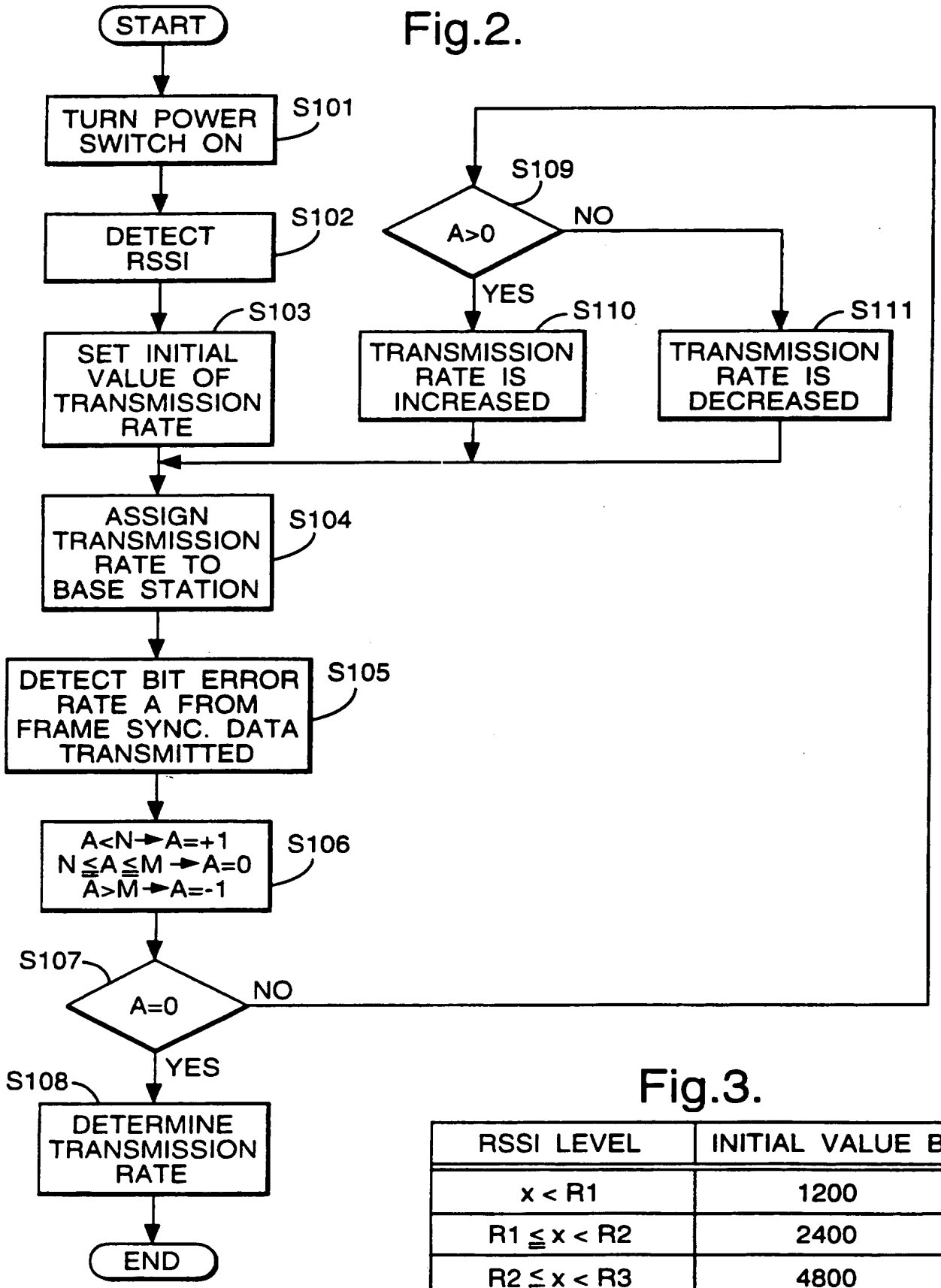


Fig.3.

RSSI LEVEL	INITIAL VALUE B
x < R1	1200
R1 ≦ x < R2	2400
R2 ≦ x < R3	4800
R3 ≦ x	9600

2303769

COMMUNICATION EQUIPMENT WITH TRANSMISSION RATE REGULATING FUNCTION AND METHOD OF OPERATION

The present invention relates to communication equipment with a transmission rate regulating function, particularly, though not exclusively, to radio communication equipment with a transmission rate regulating function, and to a method of operation thereof.

Private communication equipment, such as a portable telephone set and a peripheral device therefor, tend to be made compact in order to improve their portability, and to make it possible to communicate, even when a user of the communication equipment is moving at high speed on a vehicle, such as a car or a train.

In the case in which communication is made via communication equipment which is moving at a high speed, however, the effect of fading becomes considerable, and the level of variation in the electric field is considerable. Therefore, there is an increase in the transmission error rate, and data transmission becomes difficult.

With facsimile equipment that uses a radio channel, it is possible to change the transmission rate of a data signal according to the level of the received electro-

magnetic wave coming from the other end of the communication link in such a way that, when the receiving level is changed, the transmission rate is lowered from the initial value of the transmission rate, which is set at the maximum transmission rate. Such facsimile equipment is disclosed in, for example, Japanese Patent Application Laid-open No. H4-90664 (JP-A-4-90664). On the other hand, with facsimile equipment which uses transmission via a cable, an optimal transmission rate is determined by calculating the S/N ratio of a channel, on the basis of a received signal level for checking the channel quality and the noise level during a non-signal period. Such cable facsimile equipment is disclosed in, for example, Japanese Patent Application Laid-open No. S61-218269 (JP-A-61-218269).

However, in the above-mentioned prior art in which a received electric field level is detected, a data error may occur due to the influence of fading. Further, in the above-mentioned prior art in which the S/N ratio is calculated, the reference value for the received signal level is liable to become unstable due to the influence of fading on the transmission channel.

Features of an arrangement illustrative of the invention and to be described below, by way of example, are that radio communication equipment is improved by the provision of a transmission rate regulating function, and

by the provision of such a function which includes the detection of an optimal transmission rate on the basis of the field strength of a received electric signal and a bit error rate.

In a particular arrangement illustrative of the present invention, and to be described below, by way of example, a communication equipment with a transmission rate regulating function includes a detector for detecting the electric field level of a signal received from another communication station, a transmission rate determining circuit for assigning a transmission rate to a control signal from the other station according to the received electric field level detected by the detector, a control circuit and a bit error rate detector for detecting a bit error rate, wherein the transmission rate determining circuit determines an optimal transmission rate by regulating the assigned transmission rate according to the bit error rate detected by the bit error detector.

In one arrangement the control circuit assigns the transmission rate determined by the transmission rate determining circuit to the other station.

In a particular arrangement the detector determines the receiving electric field level on the basis of a voltage value of the received signal.

In another arrangement the bit error rate detector portion detects the bit error rate by using the frame sync data of the control signal.

In yet another arrangement to be described below, by way of example and illustrative of the invention, a communication equipment with a transmission rate regulating function includes a receiving circuit for receiving a signal from another communication station, a level detector for a received electric field for detecting the level of the electric field of the signal received by the receiving circuit, a bit error rate detector for detecting a bit error rate of the signal received by the receiving circuit and a transmission rate determining circuit for setting an initial value of the transmission rate according to the received electric field level detected by the received electric field level detector and determining an optimal transmission rate by regulating the initial value according to the bit error rate detected by the bit error rate detector.

In one arrangement the bit error rate detector detects a bit error rate from a signal received after the initial value of the transmission rate is determined by the transmission rate determining portion.

Further, in another arrangement the communication equipment includes a data terminal circuit which has a user interface function and manages data storage, and

a modem for modulating and demodulating data in communication with the other station.

There will also be described below, in illustration of another aspect of the present invention, a control method for regulating the signal transmission rate of a communication equipment, which includes the steps of detecting a received electric field level of a signal from another station, assigning the transmission rate of a control signal from the other station according to the detected received electric field level, detecting the bit error rate of the control signal and determining an optimal transmission rate by regulating the assigned transmission rate, according to the detected bit error rate.

In yet a further aspect of the present invention to be described below, by way of example, a control method for regulating the signal transmission rate of a communication equipment includes the steps of receiving a signal from another station, detecting the electric field level of the received signal, setting an initial value of the transmission rate, according to the detected received electric field level, and determining an optimal transmission rate by regulating the initial value, according to the detected bit error rate.

Arrangements, illustrative of the present invention, will now be described, by way of example, with reference

to the accompanying drawings in which:

Fig. 1 is a block schematic circuit diagram,

Fig. 2 is a flow chart for use in illustrating the operation of the embodiment shown in Fig. 1, and

Fig. 3 is a table showing the relation between a received electric field level and a transmission rate.

In Fig. 1, a mobile radio communication equipment 10 has a radio receiver circuit 1, an RSSI (Received Signal Strength Indication) level detector 2, a modem 3, a bit error rate detector 4, a transmission rate determining circuit 5, a control circuit 6, a data terminal circuit 7, a power switch 8, and a power source 9.

The radio circuit 1 of the mobile radio communication equipment 10 has an interface function for an infra radio station and transmits/receives a signal to/from a base station 20. The RSSI level detector 2 receives a radio signal transmitted continuously by the base station 20 and received by the radio circuit 1, and detects the level of the electric field of the received radio signal. The received electric field level thus detected is converted into a voltage value and an RSSI level, which becomes a reference for an initial value of the transmission rate which is detected.

The modem 3 modulates and demodulates the communication data. The bit error rate detector 4 detects the bit error rate for finely regulating the

transmission rate, on the basis of frame sync data from the modem 3. The frame sync data is inserted into and around a header portion of a control signal from the base station 20.

The transmission rate determining circuit 5 sets the initial value of the transmission rate on the basis of the RSSI level from the RSSI level detector 2, and determines the optical transmission rate by finely regulating the initial value on the basis of the bit error rate from the bit error rate detector 4. The control circuit 6 controls the operation of various circuit portions of the mobile radio communication equipment 10. The data terminal circuit 7 has a user interface function and manages data storage. The power switch 8 is adapted to be manually operated, on/off, by a user to connect and disconnect the power source 9 to the various circuit portions.

Now, the operation of the mobile radio communication equipment 10 shown in Fig. 1 will be described with reference to the flowchart shown in Fig. 2.

The control circuit 6 detects when the power switch 8 is turned on (step S101), and supplies the power source voltage to the radio portion 1. In response thereto, a receiving circuit of the radio circuit 1 starts to receive a radio signal which has a predetermined frequency and is transmitted continuously at a

predetermined transmission rate by the base station 20. The RSSI level detector 2 detects the level of the received electric field of the radio signal received by the radio circuit 1 and detects the RSSI level by converting the received electric field level into a voltage value (step S102). The transmission rate determining circuit 5 determines an initial value B of the data transmission rate on the basis of the RSSI from the RSSI level detector 2 (step S103).

Fig. 3 shows a preferred relation between the RSSI level and the initial value B of the transmission rate. In Fig. 3, the detected RSSI level x is compared with predetermined RSSI levels R1, R2 and R3, respectively, where R1 < R2 < R3. When the detected RSSI level x is lower than the predetermined first value R1, the initial value B of the transmission rate is set to 1200 bps. When the detected RSSI level x is not lower than the predetermined second value R2, but it is lower than the third value R3, the initial value B is set to 4800 bps. When the detected RSSI level x is not lower than the third value R3, the initial value B of transmission rate is set to 9600 bps.

The control circuit 6 responds to the initial value B of the transmission rate determined in the step S103 to request the radio circuit 1 to transmit a transmission rate assigning signal to the base station 20. The radio

circuit 1 transmits the transmission rate assigning signal instructing communication to take place at the initial value B of transmission rate to the base station 20, upon the request from the control circuit 6 (step S104). When, for example, the detected RSSI level x is lower than the first level R1, the transmission rate assigning signal instructing transmission to take place at the initial value 9600 bps is sent to the base station 20.

In response to the transmission rate assigning signal, the base station 20 sends the control signal, including the frame sync data, to the mobile radio communication equipment 10. The frame sync data received by the radio circuit 1 is supplied through the modem 3 to the bit error rate detector 4. The bit error rate detector 4 detects a bit error rate A of the frame sync data (step S105) and ranks the detected bit error rate (step S106).

The detected bit error rate y is compared with predetermined first and second threshold values N and M, respectively, where N < M). It is preferable that the bit error rate is of the order of 1%. For example, the threshold values N and M are 0.5% and 1.2%, respectively. When the detected bit error rate y is smaller than the first threshold value N = 0.5%, the bit error rate A is ranked as "+1". When the detected bit error rate y is

not smaller than the first threshold value N = 0.5% and is not larger than the second threshold value M = 1.2%, the bit error rate A is ranked as "0". When the detected bit error rate y is larger than the second threshold value M = 1.2%, the bit error rate A is ranked as "-1".

When the rank of the bit error rate A is 0 after the ranking operation in the step S106 (YES in step S107), it is determined that the initially set transmission rate is appropriate and the transmission of data is started at the initial value B of the transmission rate (step S108).

When the rank in the step S107 is not 0 (NO in step S107), it is determined whether the rank is larger than 0 (step S109). That is, when the transmission rate is not appropriate, it is determined whether the tranmission rate is higher or lower than the appropriate value. When the rank is larger than 0, that is, the transmission rate is determined as lower, the transmission rate is increased and a new transmission rate is set (step S110). On the other hand, when it is determined that the rank is smaller than 0, that is the transmission rate is higher, the transmission rate is decreased and another new transmission rate is newly set (step S111).

For example, when the initial transmission rate is 4800 bps and the bit error rate A is ranked as "H", a new transmission rate 9600 bps is set. On the other hand, when the initial transmission rate is 4800 bps and the

bit error rate A is ranked as "-1", a new transmission rate 2400 bps is set.

When such a new transmission rate is set, the control circuit 6 controls the radio circuit 1 to send a signal assigning the newly set transmission rate to the base station 20. In response to the signal, the base station 20 sends the control signal at the newly set transmission rate. The processing operation from the step S104 to the step S111 is repeated until the transmission rate becomes appropriate.

As explained above, with the arrangement described, it is possible to determine quickly the optimal transmission rate by assigning a desired transmission rate to the base station after the initial value of the transmission rate has been set by detecting the level of the received electric field, and controlling the transmission rate optimally, on the basis of the bit error rate of the control signal from the base station. Therefore, it becomes possible to improve the efficiency of information management.

While the present invention has been illustrated, by way of example, with reference to a specific embodiment thereof, it will be appreciated that variations and modifications thereof, as well as other embodiments are possible within the scope of the protection sought by the appended claims.

CLAIMS

1. Communication equipment with a transmission rate regulating function, including

a level detector for detecting the level of the electric field of a received radio signal transmitted from another station,

first assigning means for assigning a transmission rate to a control signal to be transmitted from the other station, according to the level of the electric field of the received signal detected by the level detector,

means for detecting the bit error rate of a control signal transmitted from the other station, and means for determining an optimal transmission rate by regulating an assigned transmission rate according to the detected bit error rate.

2. Communication equipment as claimed in claim 1, including second assigning means for assigning an optimal transmission rate, determined by the determining means, to the other station.

3. Communication equipment as claimed in claim 1, wherein the first assigning means determines the receiving electric field level on the basis of a voltage value of the received signal.

4. Communication equipment as claimed in claim 1, wherein the bit error rate detector detects the bit error rate by using the frame sync data of the control signal.

5. A radio communication equipment with a transmission rate regulating function, including

receiving means for receiving a signal from another station,

first detection means for detecting the level of the electric field of the signal received by the receiving means,

second detection means for detecting the bit error rate of the signal received by the receiving means, and

transmission rate determining means for setting an initial value of the transmission rate according to the level of the received electric field detected by the first detection means and for determining a more preferable transmission rate by regulating the initial value of the transmission rate according to the bit error rate detected by the second detection means.

6. A radio communication equipment as claimed in claim 5, including means for assigning the initial value of the transmission rate and the more preferable transmission rate to the other station.

7. A radio communication equipment as claimed in claim 6, wherein the second detection means detects the bit error rate from a signal received after the assigning means has assigned the initial value of the transmission rate.

8. A radio communication equipment as claimed in claim 5, wherein the level of the received electric field is detected as a voltage value.

9. A radio communication equipment as claimed in claim 5, including

a data terminal portion having a user interface function and managing a storage of data, and

a modem portion for modulating and demodulating communication data transmitted to and from the other station.

10. A control method for regulating the signal transmission rate of a communication equipment, including the steps of

detecting the level of the electric field of a radio signal received from another station,

assigning a transmission rate to a control signal from the other station according to the level of the

received electric field detected in the detecting step,

detecting the bit error rate of the control signal transmitted from the other station, and

determining a more preferable transmission rate by regulating the assigned transmission rate according to the detected bit error rate.

11. A control method as claimed in claim 10, including the step of assigning the determined more preferable transmission rate to the other station.

12. A control method as claimed in claim 10, wherein the bit error rate is detected from the frame sync data of the control signal.

13. A control method for regulating the signal transmission rate of a radio communication equipment, including the steps of

receiving a signal transmitted from another station,

detecting the level of the electric field of the received signal,

detecting the bit error rate of the received signal, and

setting an initial value of the transmission rate according to the detected received electric field level and determining a more preferable transmission rate by

regulating the initial value of transmission rate according to the detected bit error rate.

14. Communication equipment as claimed in either claim 1 or claim 5 substantially as described herein with reference to Figs. 1 and 2 of the accompanying drawings.

15. A control method as claimed in either claim 10 or claim 13 substantially as described herein with reference to the accompanying drawings.

The Patent Office

17

Application No: GB 9615688.0
Claims searched: all

Examiner: Nigel Hall
Date of search: 6 November 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDG); H4P (PAQ)

Int Cl (Ed.6): H04L 1/12 ; H04B 7/005

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	EP 0565230 A2 (IBM)	
A	WO 92/22162 A1 (BRITISH TELECOM)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.